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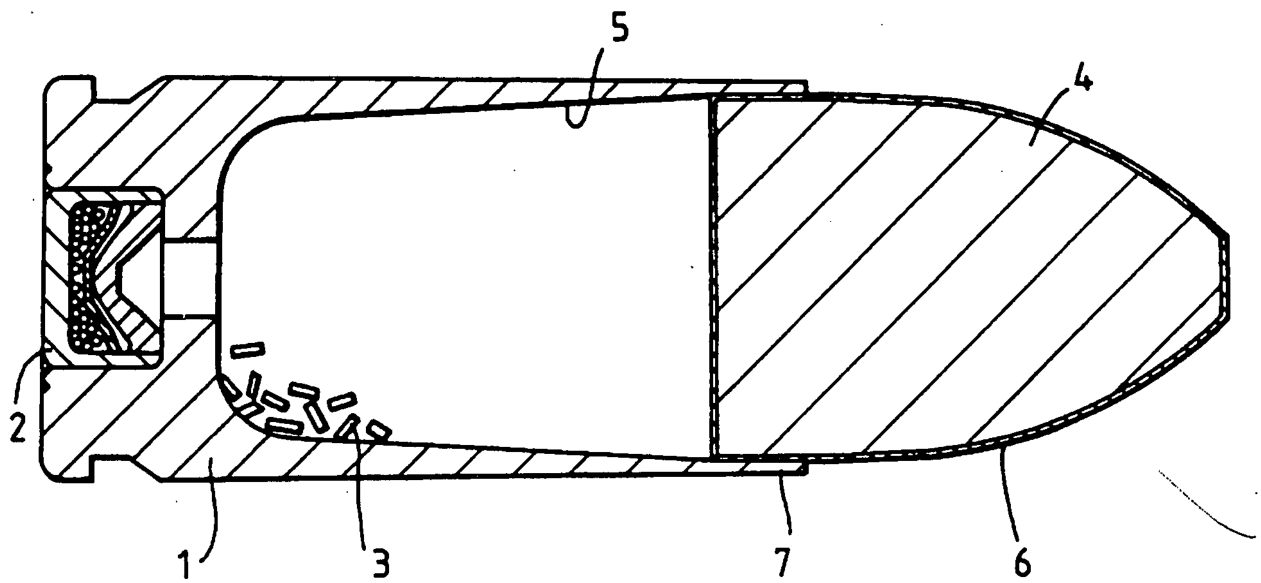
(54) **Projectiles**

(57) A projectile, especially a small arms bullet, comprises a metal core (4) formed from a sintered metal powder and an adherent coating (6) eg of plastics material such as polyamide 11 or a metal such as Cu, Zn, Ni. The metal powder may be steel, tungsten, copper, bronze, or especially iron. The projectile may be rendered frangible by selection of appropriate particle size and sintering parameters, and is then suitable as practice ammunition. The coating can be applied by immersing the hot projectile in a fluidised bed containing particles of the plastics material.



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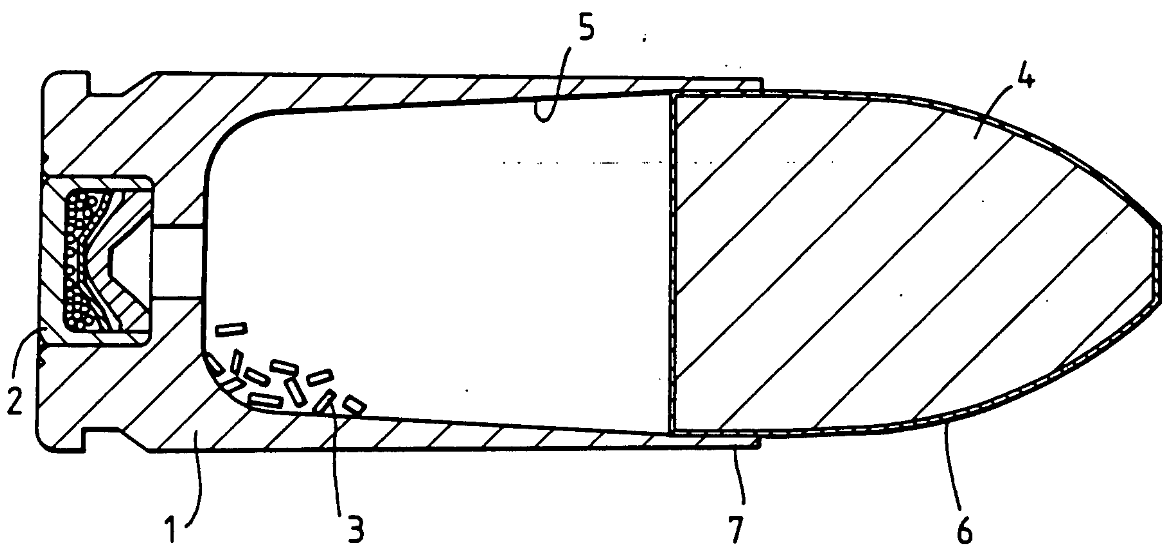
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TITLE IMPROVEMENTS IN OR RELATING TO PROJECTILES

This invention relates to projectiles and especially but not exclusively to frangible training projectiles for small arms up to about 12.7mm calibre.

For training applications it is highly desirable to provide ammunition which is relatively safe in use but resembles the performance of standard ammunition as closely as possible in a standard weapon without the need for any modification. For maximum realism, the training round should be capable of normal operation of all automatic weapon functions such as single shot and automatic modes of fire and ejection, and should provide a realistic level of recoil. In addition the practice ammunition should have a projectile which can be fired at a target but should then rapidly lose energy so as to reduce the danger of ricochet or lethal fragments.

According to one prior proposal, a practice round of ammunition has a case of plastics material with an integrally moulded projectile, but a special design of weapon is required to simulate automatic operation, including extraction and reloading functions. The user will experience a report, but the recoil force will be considerably less than with a standard system, and although a projectile can be fired at a target, its range is extremely limited. This system provides some basic practice in weapon handling but is relatively unrealistic.

Efforts have mainly in the past been directed to ammunition based on more conventional designs, but having a projectile of a plastic matrix filled with metal particles. By this means a projectile having a reasonably high density can be produced, which can be fired from a standard, unmodified weapon at a target to give realism.

Projectiles of this kind have been successfully produced and used with copper or bronze particles in a plastics matrix. They are relatively expensive to produce, and the maximum density achievable with this type of material is of the order of 4 gm/cc. These projectiles can provide realistic operation with gas-operated automatic weapons (such as many 5.56mm weapons) and also realistic recoil forces of the order of two-thirds that experienced with the standard ammunition. In addition these projectiles can be designed as frangible so that they break up with reduced ricochet on striking a hard target.

However, most 9mm automatic weapons and also a significant proportion of 7.62 and 5.56mm automatic weapons operate on the delayed blow-back or short recoil principle, and these weapons require a denser projectile material for automatic operation. Attempts have been made to produce a tungsten-filled plastics projectile (having a density up to 6gm/cc) for such applications, but these have been unsuccessful because tungsten generates unacceptable barrel wear.

There thus exists a need for a training projectile which is frangible but provides realistic automatic weapon operation in both standard, conventional gas-operated, delayed blow-back and short recoil weapons and at lower cost then existing metal-filled plastics designs. In addition it would be highly desirable if means could be provided for enabling a projectile comprising tungsten or other relatively dense but abrasive material to be fired through a conventional barrel without causing excessive wear.

The present invention seeks to make possible a solution to some or all of these requirements.

According to the present invention there is provided a projectile comprising a metal core which is formed from a sintered metal powder and an adherent coating.

Preferably the coating is formed of a plastics material, although in some instances a metal coating may be suitable. Possible metal coating materials include copper, nickel and zinc, or alloys in which one or more of these materials is a major constituent. In many instances it will be advantageous for the coating material to be softer, having a lower hardness and/or ductility than the metal core material.

The metal powder is advantageously selected from the group comprising iron, steel, tungsten, copper and bronze powders. By avoiding the use of lead, and especially through use of an iron powder, environmental pollution caused by the projectiles, eg on a training range, is substantially reduced.

Where the metal powder is of iron, the projectile is preferably formed from a coarse iron powder having a particle size range up to 200 microns when a frangible projectile is required. Preferably the particles are in the size range 20 – 150 microns.

Where the powder is of iron, and a frangible projectile is required, the projectile is formed by sintering a pressed preform at a temperature in the range 600 to 800°C, preferably in the range 650–750°C.

Projectiles which are not easily frangible are also within the scope of the invention, and such projectiles may be formed by sintering at higher temperatures, ie in excess of 800°C.

The plastics material should have a melting point in excess of about 170°C, should form a non-brittle adherent coating on the projectile, and should be compatible with materials normally used in small arms propellant, including nitrocellulose and nitroglycerine.

Suitable plastics materials include polyamides, including especially polyamide 11. Polycarbonates and polyesters may also be suitable as the plastics material.

The thickness of the coating of plastics material should exceed the depth of rifling encountered by the projectile in the weapon from which it is to be fired, and thus a thickness in the range 0.05 to 0.40mm is desirable, and preferably the thickness should normally be in the range 0.08 to 0.15mm for most applications.

Most conveniently the coating is applied by heating the projectile to a temperature above the melting point of the plastics material, and immersing the projectile in a fluidised bed containing particles of the plastics material.

The use of a plastics coating can lead to several practical advantages. The plastics material bonds efficiently with the naturally irregular surface of the sintered projectile, so that the coating does not readily separate from the projectile during firing. The rifling of the gun barrel easily engraves the plastics coating which acts as a soft interface and protects the barrel from contact with the projectile, thus reducing barrel wear while enabling dense and/or abrasive projectile material to be used for the projectile. Where frangibility is desired, the projectile can be sintered by a sintering process in which the process parameters are selected so as to create a mechanically weak material which easily disintegrates on striking a hard target. The plastics coating assists in maintaining the integrity of the projectile during the firing cycle, and also can act as a seal which prevents or resists corrosion of the projectile material.

The invention will now be described by way of example only with reference to the accompanying drawing, which shows in sectional form a practice round of ammunition incorporating a projectile in accordance with the invention.

As shown in the figure, a round of ammunition comprises a conventional cartridge case 1 having a conventional primer 2 and containing a quantity of propellant material 3.

A projectile 4 is received within the open end of the cartridge case 1, to a depth suitable for correct weapon feeding and operation.

The projectile 4 is provided on its outer surface with a coating 6 of a plastics material such as polyamide 11 (Nylon 11).

On assembly the projectile 4 is inserted into the forward end 7 of the cartridge case. The portion 7 is then crimped on to the projectile in the conventional manner, so that the projectile is retained in position.

The projectile 4 is formed from a coarse iron powder by pressing and sintering.

The frangibility of the finished projectile can be controlled by control of the pressure used for producing the green preform, and the temperature and duration of the sintering process, as well as the particle size of the iron powder. A sintering temperature between about 600°C and 800°C can give satisfactory results when a projectile which disintegrates on impact with the target is required. The duration of the sintering process is believed to be less critical, but a period of about 1 to 5 hours within the stated temperature range should normally be satisfactory.

The sintered projectile may be coated with the plastics material in the following manner. The projectile is first heated to a temperature above the melting point of the plastics material, and then is placed in a fluidised bed containing particles of the plastics material at room temperature. Particles of plastics material melt in contact with the hot projectile surface, and thus adhere to the surface. The thickness of the adherent layer will depend primarily upon the initial temperature of the projectile, and can thus be controlled by this means. In order to provide a smooth surface finish, the coated projectile can subsequently be subjected to infra red heating, to remelt the outer surface of the coating. The melting point of the plastics material should preferably be not less than about 170°C, as temperatures up to this level can in certain circumstances be encountered within a gun chamber during use.

In practice the thickness of the plastic coating should preferably be at least equal to the depth of rifling in the barrel of the weapon for which the projectile is intended. A thickness in the range 0.08 to 0.15mm will frequently be found satisfactory.

In use, when fired from a standard automatic weapon, the projectile can be designed having sufficient mass to ensure normal operation of the automatic weapon function. If a greater mass is required than can be achieved within the available space envelope using iron powder, then other powder materials or mixtures thereof may be used, but iron is preferred on account of its low cost.

The projectile should normally have a minimum density of about 6gm/cc for use in a blow-back or short recoil operated weapon. A density of 4.5 to 5 gm/cc might be

adequate for a gas operated weapon, but it is unlikely any benefit would accrue from use of such low density.

The foregoing description applies principally to frangible training ammunition. However, the invention also can be applied with advantage to enable the use of sintered metals for warshot projectiles which may lead to cost savings and/or enable the use of materials which would normally cause unacceptable barrel wear on account of the abrasiveness or hardness of the material.

Thus also to be considered within the scope of the invention are projectiles in which the metal core is formed of sintered metal which has been sintered for a longer period and/or at a higher temperature than those specific times or temperatures previously indicated herein, in order to produce a projectile which is not readily frangible.

Claims

1. A projectile comprising a metal core which is formed from a sintered metal powder, and an adherent coating.
2. A projectile according to claim 1 wherein the coating material is metal.
3. A projectile according to claim 2 wherein the coating material is selected from copper, nickel, zinc and alloys in which one or more of these materials is a major constituent.
4. A projectile according to claim 1 wherein the coating is of a plastics material.
5. A projectile according to any one preceding claim wherein the metal powder is selected from the group comprising iron, steel, tungsten, copper and bronze powders.
6. A projectile according to claim 5 wherein the metal powder is a coarse iron powder having a particle size range up to 200 microns.
7. A projectile according to claim 6 wherein the metal powder is a coarse iron powder having a particle size in the range 20 – 150 microns.
8. A projectile according to claim 6 or claim 7 wherein the projectile is formed by sintering at a temperature in the range 600 to 800°C.
9. A projectile according to claim 4 wherein the plastics material has a melting point in excess of 170°C.
10. A projectile according to claim 9 wherein the plastics material is selected from the group comprising polyamides, polycarbonates and polyesters.
11. A projectile according to claim 10 wherein the plastics material is polyamide 11.
12. A projectile according to any one of claims 4 to 11 wherein the thickness of the plastics coating is in the range 0.05 to 0.40mm.
13. A projectile according to claim 12 wherein the thickness of the plastics coating is in the range 0.08 to 0.15mm.
14. A projectile according to any one of claims 4 to 13 wherein the coating is applied by heating the projectile to a temperature above the melting point of the plastics material and immersing the projectile in a fluidised bed containing particles of the plastics material.
15. A projectile in accordance with any preceding claim which is a small arms projectile.
16. A projectile according to claim 15 which is to a calibre of 5.56 mm, 7.62mm or 9mm.

17. A projectile according to claim 1 and substantially as hereinbefore described.

18. A projectile substantially as hereinbefore described with reference to the accompanying drawing.

19. A round of ammunition incorporating a projectile in accordance with any preceding claim.

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Patents Act 1977 **Examiner's report to the Comptroller under Section 17** **(The Search report)**	Application number GB 9410023.7
Relevant Technical Fields (i) UK Cl (Ed.M) F3A (ii) Int Cl (Ed.5) F42B	Search Examiner R C SQUIRE
	Date of completion of Search 20 JULY 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLIINE DATABASE: WPI	Documents considered relevant following a search in respect of Claims :- 1 TO 19

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2125523 A	(RHEINMETALL)	1,2,5
X	US 4727639	(U THEIS)	1,2,5

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